

# Growth Rates of American Alligators in Estuarine and Palustrine Wetlands in Louisiana

WILLIAM L. ROOTES

ROBERT H. CHABRECK

*School of Forestry, Wildlife, and Fisheries  
Louisiana State University Agricultural Center  
Baton Rouge, Louisiana 70803*

VERNON L. WRIGHT

*Department of Experimental Statistics  
Louisiana State University Agricultural Center  
Baton Rouge, Louisiana 70803*

BOBBY W. BROWN

*United States Fish and Wildlife Service  
HCR 63, Box 186  
Lake Arthur, Louisiana 70549*

THOMAS J. HESS

*Louisiana Department of Wildlife and Fisheries  
Route 1, Box 20-B  
Grand Chenier, Louisiana 70643*

**ABSTRACT:** A comparative study of American alligator (*Alligator mississippiensis*) growth rates was made in estuarine and palustrine wetlands in southwestern Louisiana. In the estuarine wetlands, where characteristic salinity levels were  $\leq 5\text{‰}$ , alligators grew faster and therefore reached sexual maturity earlier than did those in palustrine wetlands, which are characterized by shallow, freshwater marsh vegetation. Slower growth rates in palustrine wetlands appeared to be related to prey density, indicated by previous studies to be lower than in estuarine wetlands. Males grew faster than females and therefore reached sexual maturity at an earlier age in both habitats. This study revealed a major limitation in using total lengths as an index upon which population age structure can be based even when alligators are in the same geographic region.

## Introduction

Growth data on American alligators have been reported by McIlhenny (1934), Hines et al. (1968), and Bara (1972), Chabreck and Joanen (1979), and Dietz (1979). The findings of Chabreck and Joanen (1979) were based on observations of 304 marked and recaptured individuals. Their work was done in estuarine wetlands in southwestern Louisiana and offered a reference for comparative work in palustrine wetlands in the same geographical area. Such a comparison was of interest because much of the Louisiana alligator habitat is in palustrine wetlands (McNease and Joanen 1978). We tested the hypotheses that there were no differences be-

tween estuarine and palustrine wetlands in alligator growth rates or weight-length relationships.

## Methods

### STUDY AREAS

The general characteristics of estuarine and palustrine wetlands were described by Cowardine et al. (1979). The estuarine habitat reported on by Chabreck and Joanen (1979) was located on Rockefeller Refuge. The area is part of a state wildlife refuge on the coast of the Gulf of Mexico. It encompasses numerous bayous, canals, and shallow ponds which account for 7,765 ha of alligator hab-

itat. Salinity levels may reach 18‰ but characteristically are  $\leq 5\%$ .

The palustrine study site was located at Lacassine Pool, Lacassine National Wildlife Refuge, which was 20 km inland from Rockefeller Refuge. This permanently flooded 6,478 ha impoundment was characterized by floating freshwater marsh interspersed with shallow ponds, canals, and ditches. Open water depths ranged from 0.3 m to 1.0 m and contained both submerged and floating vegetation. Water input was entirely by rainfall and outflow was through three spillways.

Alligator hunting has been prohibited at Rockefeller Refuge since 1943, although several hundred individuals (mostly immature) were removed and relocated to understocked sites in Louisiana in the 1960s. Removal of alligators from Lacassine Pool was prohibited from 1937 through 1982. In the period 1983 through 1987, 753 individuals were removed in a commercial hunting program. During the periods in which data reported in this study were collected, populations at both sites were thought to be at or near carrying capacity.

#### DATA COLLECTION AND ANALYSIS

Data collection entailed capture, measurement, sex determination, mark, and release at each study site. Techniques employed were described by Chabreck (1963). Measurements consisted of total length (TL) and weight. Marking was by attachment of a numbered monel tag to the dorsal scutes of alligators at the estuarine site and by attachment of same-numbered monel tags to the webbing of each of three feet at the palustrine site. Upon recapture the alligators were remeasured and rechecked for correct sex identification. The von Bertalanffy growth curve (von Bertalanffy 1960) was used as a model to describe length growth over time. The model was

$$x = a(1 - be^{-kt})$$

where  $x$  = TL (m) at time of capture,  $t$  = age (years),  $b$  = TL at hatching, and  $a$  and  $k$  were parameters to be estimated. The Fabens (1965) modification of the von Bertalanffy model which would accommodate our capture-recapture data was

$$y = x + (a - x)(1 - e^{-kd})$$

where  $x$  = TL at first capture,  $y$  = TL at recapture, and  $d$  = time lapse (years) between initial capture and last capture.

Since Chabreck and Joanen (1979) found that alligators in southern Louisiana did not feed from November through February, and presumably therefore only grew during eight months of each year,  $d$  was adjusted by a factor of 0.67. Values for  $a$  and  $k$  were estimated by the least square methods

using PROC NLIN (SAS Institute, Inc. 1985). Partial  $F$  tests were used for comparisons of growth curves.

The model used for weight-length comparisons was

$$W = aL^b$$

where  $W$  = weight (kg),  $L$  = TL (m), and  $a$  and  $b$  were parameters that were to be estimated by PROC NLIN. The model was logarithmically transformed to allow simple linear regression analysis. Comparisons between habitat types and sexes were made by  $t$ -tests and partial  $F$ -tests (Steel and Torrie 1980), respectively.

#### Results

In the estuarine wetlands, 2,500 alligators were captured and 304 were recaptured between 1959 and 1976. Weights were obtained on 222 individuals. In the palustrine wetlands, the database consisted of sex and TL information on 4,800 alligators captured and 441 recaptured or harvested between 1981 and 1988. In 1988, weight data were collected on 249 harvested alligators. Total length at hatching was based on 285 observations and was set at 0.24 m.

Growth curves described by the von Bertalanffy model differed between sexes within each habitat type (estuarine:  $F = 56.11$ ,  $df = 2$ ,  $302$ ,  $p < 0.0001$ ; palustrine:  $F = 37.68$ ,  $df = 2$ ,  $437$ ,  $p < 0.0001$ ) and within sexes between habitats (males:  $F = 166.48$ ,  $df = 2$ ,  $451$ ,  $p < 0.0001$ ; females:  $F = 47.64$ ,  $df = 2$ ,  $288$ ,  $p < 0.0001$ ). Males grow faster than females, and both males and females grew faster in estuarine than in palustrine wetlands (Table 1, Fig. 1).

The minimum size of sexual maturity of male and female alligators is about 1.83 m TL (Giles and Childs 1949; Joanen and McNease 1980; Klause 1984), and the age at which an alligator reaches sexual maturity is dependent upon how long it takes the animal to reach 1.83 m TL (Klause 1984). The growth models predicted the age of male sexual maturity in estuarine and palustrine wetlands to be 6 and 10 years, respectively. In the case of females, ages at sexual maturity were 8 and 13 years in estuarine and palustrine wetlands, respectively.

The weight-length regressions did not differ between sexes within habitats (estuarine:  $F = 0.20$ ,  $df = 2$ ,  $220$ ,  $p > 0.05$ ; palustrine:  $F = 1.59$ ,  $df = 2$ ,  $245$ ,  $p > 0.05$ ). Analysis of the simple linear regressions based on logarithmically transformed data showed no difference between habitats in slope values ( $t = 0.77$ ,  $df = 469$ ,  $p > 0.05$ ), but intercepts were different ( $t = 7.86$ ,  $df = 469$ ,  $p < 0.0001$ ). Models using non-transformed data were

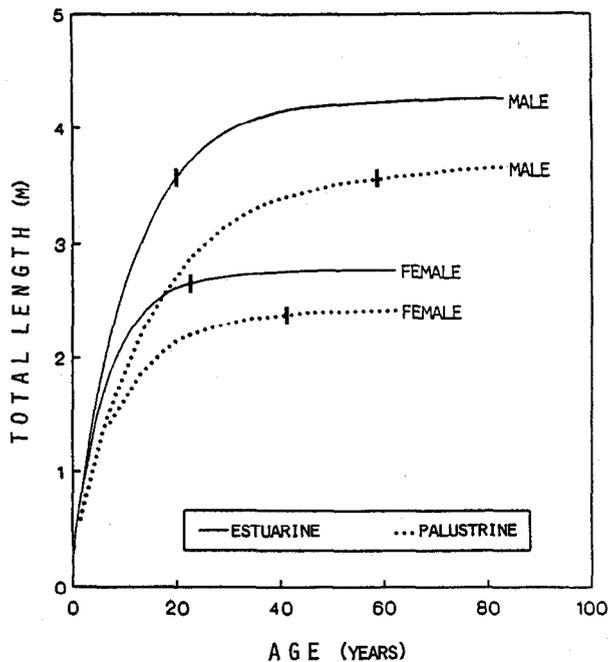


Fig. 1. Length-age relationships derived from capture-recapture data on alligators in estuarine wetlands from 1959 to 1976 and in palustrine wetlands from 1981 to 1988. Vertical bars indicate the limits of actual data.

estuarine wetlands:

$$W = 2.84L^{3.342} \quad (r^2 = 0.98)$$

palustrine wetlands:

$$W = 1.86L^{3.593} \quad (r^2 = 0.97)$$

These models seemed to suggest that alligators in the palustrine wetlands had a lower weight-length density than did those in estuarine wetlands and thus may have been in poorer nutritional condition (Fig. 2).

### Discussion

Prey size of alligators varies with size of the predator (Wolfe et al. 1987). Diets of juvenile alligators consist largely of invertebrates and small fishes (Chabreck 1971; Valentine et al. 1972; Fogarty

TABLE 1. Coefficient values and percentages of explained variance ( $r^2$ ) for the von Bertalanffy growth model,  $x = a(1 - be^{-kt})$ , for alligators in southwestern Louisiana.<sup>a</sup>

Habitat	Sex	Coefficient			$r^2$ (%)
		a	b	k	
Estuarine	Male	4.23	0.24	0.0107	96
	Female	2.74	0.24	0.0197	91
Palustrine	Male	3.65	0.24	0.0078	97
	Female	2.39	0.24	0.0128	92

<sup>a</sup>  $x$  = total length in meters at the time of capture,  $b$  = total length in meters at hatching, and  $t$  = age in years multiplied by 0.67 to correct for eight months of growth per annum.

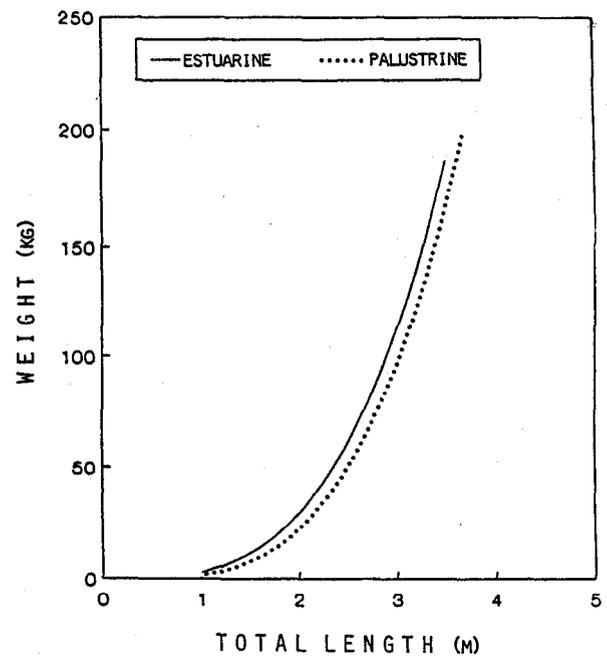


Fig. 2. Weight-length relationships of alligators in estuarine wetlands from 1959 to 1976 and palustrine wetlands in 1988.

and Albury 1967). Adult alligators consume mainly vertebrates (Delany and Abercrombie 1986; Wolfe et al. 1987), and in Louisiana mammals are the major food of alligators >1.5 m TL (Wolfe et al. 1987). Adult alligators often shift from a diet of muskrats (*Ondatra zibethicus*) to the larger nutria (*Myocastor coypus*) as the alligator length increases. Differences between diets of immature and adult alligators indicate resource partitioning and may reduce intraspecific competition between age groups. Webb et al. (1978) found differences in prey size of immature and adult estuarine crocodiles (*Crocodylus porosus*) and stated that the differences allowed energy gain by feeding on different size prey. Resource partitioning also may be a key factor for sexual size dimorphism in adult alligators; and differences in body size may decrease intersexual dietary competition and increase feeding efficiency and fitness. Delaney and Abercrombie (1986) reported that adult male alligators in Florida consumed mainly reptiles and fish but adult females consumed mainly mammals. Sexual size dimorphism and dietary partitioning also have been noted in lizards (Powell and Russell 1984) and snakes (Madsen 1983).

In our study, male alligators grew faster than females after they reached 1 m TL; therefore, males became considerably larger than females. Andrews (1982) noted that in species in which males are larger than females, the males attain greater size by faster growth as juveniles and by growth that

continues after sexual maturity is reached. The slower growth rate of adult female alligators as compared to adult males may be related to the greater energy expenditure by females during reproduction. Webb et al. (1983) noted that male freshwater crocodiles (*Crocodylus johnstoni*) grow faster than females and reach a greater size. They stated that the slower growth of females reflects energy costs associated with egg production, but growth also is genetically determined.

Adult male alligators move considerably more than adult females (Chabreck 1965), and Joanen and McNease (1989) reported that the home range of adult males ranged from 191 ha to 5,024 ha, while the home range of adult females averaged only 8 ha. Cannibalism is common among alligators, and small adults are frequently predated by large adults (Rootes 1989); the chances of being predated by a larger alligator decreases as the size of an alligator increases. Although adult males travel a great deal, they are able to avoid predation by continued rapid growth after maturity and thus reach a size that minimizes the chance of predation. Jacobsen and Kushlan (1989) reported that slow growth increased the susceptibility of alligators to predation. Gibbons et al. (1981) noted that by rapid growth the slider turtle (*Pseudemys scripta*) was able to achieve a minimum size that allowed it to avoid predation.

Female alligators avoid predation after maturity by reducing movement and by occupying remote, densely vegetated habitat (Chabreck 1965, 1966) until they reach a size that allows them to avoid most predators (Schulte 1989). Reproductive success in female alligators is size dependent, with large adults laying more frequently and laying larger clutches of eggs than small adults (Wilkinson 1983). By reducing energy expenditure on reproduction, small adults are able to maximize growth. King (1986) reported that the proportion of gravid females of the Lake Erie water snake (*Nerodia sipedon insularum*) increases with size, and smaller adult females may skip an opportunity to reproduce in favor of increased survivorship or fecundity because of the larger size achieved by using energy for growth rather than reproduction.

The difference in growth rates of alligators in the two wetland types has important implications for reproductive capacities and survivorship rates. Female alligators in palustrine wetlands required 63% longer to reach the TL of sexual maturity than females in estuarine wetlands. Once reaching sexual maturity, female alligators in palustrine wetlands were slower to grow into the larger and more productive adult size classes. These factors suggest that age-specific fecundity rates of females in palustrine wetlands were lower than those of females in estuarine wetlands.

Survivorship in juvenile alligators is a function of size (Nichols et al. 1976; Taylor and Neal 1984). Andrews (1982) noted that in most species of reptiles smaller individuals are more subject to predation and as an individual grows its probability of survival increases.

Survivorship rates were lowest in alligators <0.45 m TL and gradually increased as the size of the alligator increased. Alligators in estuarine wetlands reached 1.0 m TL in about 50% of the time required for alligators in palustrine wetlands. Because juveniles in palustrine wetlands were in the more vulnerable size classes much longer, age-specific survivorship rates may well be lower than those of alligators in estuarine wetlands.

Because of the proximity of the two study areas and the movement capabilities of alligators (Chabreck 1965), genetic variability was not considered a factor in this study. In fact, two alligators tagged in the palustrine study area were subsequently recaptured within 1.0 km of the estuarine study area. In addition, water temperatures did not differ between study areas and therefore did not cause growth rates to differ.

Differences between wetland types in growth rates and weight-length ratios are best explained by differences in resources availability. No direct measurements of the prey base available to alligators in the wetland types were made during these studies; however, several other studies suggest that prey availability was greater in estuarine wetlands. Investigations by Chabreck (1971), Joanen and McNease (1977), and Rootes (1989) indicated that invertebrates, fishes, and nutrias (*Myocastor coypus*) were major components of alligator diets in both study areas. Blue crabs (*Callinectes sapidus*) and crayfish (*Procambarus clarki*) were abundant in the estuarine wetlands (Perry et al. 1970; Davidson and Chabreck 1983), but blue crabs did not occur in the palustrine wetlands and few crayfish were observed in the area. Perry (1976) reported that the standing crop of fishes in the estuarine wetlands averaged 394 kg ha<sup>-1</sup>, and Turner (1966) found that the standing crop of fishes in the palustrine wetlands averaged only 98 kg ha<sup>-1</sup>.

Investigations by Palmisano (1973) and Linscombe and Kinler (1985) indicated that palustrine wetlands generally support a greater density of nutrias than estuarine wetlands. Also, trapping records show that the harvest of nutrias on Rockefeller Refuge was one animal per 17 ha and on Lacassine NWR was one animal per 8 ha (United States Army Corps of Engineers 1974). However, the harvest of nutrias on Lacassine NWR was mostly on areas outside the Lacassine Pool, and during our study, trappers did not trap in the Lacassine Pool because of the low nutria population in the area.

Joanen and McNease (1987) reported that the alligator nest density in the estuarine wetlands was one nest per 7.6 ha. Alligator nest density in the palustrine wetlands was one nest per 9.2 ha in 1987 (Carbonneau 1987). If nest density on an area is proportional to alligator density on the area (Chabreck 1966), then the alligator density on the estuarine study area was similar to that on the palustrine study area.

Delany and Abercrombie (1986) noted differences among lakes in Florida in the condition of alligators and stated that the differences could not be explained and did not appear to be related to the quantity and quality (species) of food ingested. However, Jacobsen and Kushlan (1989) compared growth of alligators in palustrine wetlands of the Florida Everglades with more northerly areas and reported slower growth than most areas in spite of the longer growing season in the Everglades. They believed that limited resource availability in the Everglades, because of the lack of an adequate population of large prey, accounted for the slower growth rate. Webb et al. (1983) stated that freshwater crocodiles grew slower in upstream than downstream portions of an Australian river and related the slower growth to reduced food availability because of fewer fish upstream.

Differences in alligator growth rates, weight-length ratios, and densities suggest that estuarine wetlands provide more suitable alligator habitat than palustrine wetlands. These findings are in agreement with the observations of McNease and Joanen (1978) that the alligator density in low salinity (0.5–3.5‰) estuarine wetlands (one alligator per 3.2 ha) in Louisiana was 78.2% greater than in palustrine emergent wetlands (one alligator per 5.7 ha).

Because resource availability affects growth, it may partially regulate alligator populations through altering fecundity and survivorship rates. Age-specific fecundity and survivorship rates are important components in any population model. The great disparity in growth found in this study, along with the possibility of genetic effects in geographically distinct populations, suggest that generalized growth rates in alligator population models should be used with caution.

Considerable difference was found between the two wetland types in growth rates of smaller juvenile alligators (<1.0 m TL). The parallel nature of the weight-length regression lines of alligators from the two types indicate that the pattern of lower weight-length ratios in alligators in palustrine wetlands was established when the animals were <1.0 m TL. Thus far, all food habits studies of juvenile alligators (Giles and Childs 1949; Fogarty and Albury 1967; Chabreck 1971) have been based on alligators >1.0 m TL. Because the growth

rate of young alligators (<1.0 m TL) may greatly affect survivorship and age-specific fecundity rates of the population, the food requirements and availability to these animals must be better understood.

#### LITERATURE CITED

- ANDREWS, R. M. 1982. Patterns of growth in reptiles, p. 273–305. In C. Gans and F. H. Pough (eds.), *Biology of the Reptilia*, Vol. 13. Academic Press, New York.
- BARA, M. O. 1972. Alligator research project. Annual Progress Report of South Carolina Wildlife and Marine Resources Department, Columbia, South Carolina. 27 p.
- CARBONNEAU, D. A. 1987. Nesting ecology of an American alligator population in a freshwater coastal marsh. M.S. Thesis, Louisiana State University, Baton Rouge, Louisiana. 53 p.
- CHABRECK, R. H. 1963. Methods of capturing, marking, and sexing alligators. *Proceedings of the Annual Conference of the Southeastern Association of Game and Fish Commissioners* 17:47–50.
- CHABRECK, R. H. 1965. The movement of alligators in Louisiana. *Proceedings of the Annual Conference of the Southeastern Association of Game and Fish Commissioners* 19:102–110.
- CHABRECK, R. H. 1966. Methods of determining the size and composition of alligator populations in Louisiana. *Proceedings of the Annual Conference of the Southeastern Association of Game and Fish Commissioners* 20:105–112.
- CHABRECK, R. H. 1971. The foods and feeding habits of alligators from fresh and saline environments in Louisiana. *Proceedings of the Annual Conference of the Southeastern Association of Game and Fish Commissioners* 25:117–123.
- CHABRECK, R. H. AND T. JOANEN. 1979. Growth rates of American alligators in Louisiana. *Herpetologica* 35:51–57.
- COWARDINE, L. M., V. CARTER, F. C. GOLET, AND E. T. LAROE. 1979. Classification of wetlands and deepwater habitats of the United States. United States Fish and Wildlife Services, FWS/OBS-79/31. Washington, D.C. 103 p.
- DAVIDSON, R. B. AND R. H. CHABRECK. 1983. Fish, wildlife, and recreational values of brackish marsh impoundments, p. 89–114. In R. J. Varnell (ed.), *Proceeding of the Water Quality and Wetlands Management Conference*. Tulane University, New Orleans, Louisiana.
- DELANY, M. F. AND C. L. ABERCROMBIE. 1986. American alligator food habits in north central Florida. *Journal of Wildlife Management* 50:348–353.
- DIETZ, D. C. 1979. Behavioral ecology of young American alligators. Ph.D. Dissertation, University of Florida, Gainesville, Florida. 152 p.
- FABENS, A. J. 1965. Properties and fitting of the von Bertalanffy growth curve. *Growth* 29:265–289.
- FOGARTY, J. M. AND J. D. ALBURY. 1967. Late summer foods of young alligators in Florida. *Proceedings of the Annual Conference of the Southeastern Game and Fish Commissioners* 21:220–222.
- GIBBONS, J. W., R. D. SEMLITSCH, J. L. GREENE, AND J. P. SCHUBAUER. 1981. Variation in age and size at maturity of the slider turtle (*Pseudemys scripta*). *American Naturalist* 117:841–845.
- GILES, L. W. AND V. L. CHILDS. 1949. Alligator management of the Sabine National Wildlife Refuge. *Journal of Wildlife Management* 13:16–28.
- HINES, T. C., M. J. FOGARTY, AND L. C. CHAPPEL. 1968. Alligator research in Florida: A progress report. *Proceedings of the Annual Conference of the Southeastern Association of Game and Fish Commissioners* 22:166–180.
- JACOBSEN T. AND J. A. KUSHLAN. 1989. Growth dynamics in the American alligator (*Alligator mississippiensis*). *Journal of Zoology* 219:309–328.
- JOANEN, T. AND L. MCNEASE. 1977. Alligator diets in relation

- to marsh salinity. *Proceedings of the Annual Conference of the Southeastern Association of Fish and Wildlife Agencies* 31:36-40.
- JOANEN, T. AND L. MCNEASE. 1980. Reproductive biology of the American alligator in Southwest Louisiana, p. 153-159. In J. B. Murphy and J. T. Collins (eds.), *Reproductive Biology and Diseases of Captive Reptiles*. Society for the Study of Amphibians and Reptiles, Oxford, Ohio.
- JOANEN, T. AND L. MCNEASE. 1987. Alligator farming research in Louisiana, USA, p. 329-340. In G. W. Webb, S. C. Manalis, and P. J. Whitehead (eds.), *Wildlife Management: Crocodiles and Alligators*. Surrey Beaty and Sons, Chipping Norton, New South Wales, Australia.
- JOANEN, T. AND L. MCNEASE. 1989. Ecology and physiology of nesting and early development of the American alligator. *American Zoologist* 29:987-998.
- KING, R. B. 1986. Population ecology of the Lake Erie water snake, *Nerodia sipedon insularum*. *Copeia* 1986:757-772.
- KLAUSE, S. 1984. Reproduction characteristics of the American alligator in North Carolina. M.S. Thesis, North Carolina State University, Raleigh, North Carolina. 85 p.
- LINSCOMBE, G. AND N. KINLER. 1985. Fur harvest and distribution in coastal Louisiana, p. 187-199. In C. F. Bryan, P. J. Zwank, and R. H. Chabreck (eds.), *Proceedings of the Fourth Coastal Marsh and Estuary Management Symposium*. Louisiana State University, Baton Rouge.
- MADSEN, T. 1983. Growth rates, maturation and sexual size dimorphism in a population of grass snakes, *Natrix natrix*, in southern Sweden. *Oikos* 40:277-282.
- MCILHENNY, E. A. 1934. Notes on incubation and growth of alligators. *Copeia* 1934:80-88.
- MCNEASE, L. AND T. JOANEN. 1978. Distribution and relative abundance of the alligator in Louisiana coastal marshes. *Proceedings of the Annual Conference of the Southeastern Association of Fish and Wildlife Agencies* 32:182-186.
- NICHOLS, J. D., L. VIEHMAN, R. H. CHABRECK, AND B. FENDERSON. 1976. Simulation of a commercially harvested alligator population in Louisiana. Louisiana Agricultural Experiment Station Bulletin 691, Baton Rouge, Louisiana. 59 p.
- PALMISANO, A. W. 1973. Habitat preferences of waterfowl and fur animals in the northern Gulf Coast marshes, p. 163-190. In R. H. Chabreck (ed.), *Proceedings of the Second Coastal Marsh and Estuary Management Symposium*. Louisiana State University, Baton Rouge, Louisiana.
- PERRY, W. G. 1976. Standing crop of fishes of an estuarine area in southwestern Louisiana. *Proceedings of the Annual Conference of the Southeastern Association of Fish and Wildlife Agencies* 30:71-81.
- PERRY, W. G., T. JOANEN, AND L. MCNEASE. 1970. Crawfish-waterfowl, a multiple use concept for impounded marshes. *Proceedings of the Annual Conference of the Southeastern Association of Game and Fish Commissioners* 24:506-519.
- POWELL, G. L. AND A. P. RUSSELL. 1984. The diet of the eastern short-horned lizard (*Phrynosoma douglassi brevirostre*) in Alberta and its relationship to sexual size dimorphism. *Canadian Journal of Zoology* 62:428-440.
- ROOTES, W. L. 1989. Behavior of the American alligator in a Louisiana freshwater marsh. Ph.D. Dissertation, Louisiana State University, Baton Rouge, Louisiana. 107 p.
- SAS INSTITUTE, INC. 1985. SAS Users Guide: Statistics. SAS Institute, Inc., Cary, North Carolina. 584 p.
- SCHULTE, D. M. 1989. The effects of habitat on temperature-dependent sex determination in the American alligator. M.S. Thesis, Louisiana State University, Baton Rouge, Louisiana. 150 p.
- STEEL, R. G. D. AND J. H. TORRIE. 1980. Principles and Procedures of Statistics. McGraw-Hill Book Co., New York. 633 p.
- TAYLOR, D. AND W. NEAL. 1984. Management implications of size-class frequency distributions in Louisiana alligator populations. *Wildlife Society Bulletin* 12:312-318.
- TURNER, D. D. 1966. Distribution and abundance of fishes in impoundments of Lacassine and Sabine National Wildlife Refuges. M.S. Thesis, Louisiana State University, Baton Rouge, Louisiana. 52 p.
- UNITED STATES ARMY CORPS OF ENGINEERS. 1974. Fish and wildlife study of the Louisiana coastal area and the Atchafalaya Basin Floodway. United States Army Corps of Engineers, New Orleans, Louisiana. 727 p.
- VALENTINE, J. M., JR., J. R. WALTER, K. M. MCCARTNEY, AND L. M. IVY. 1972. Alligator diets on the Sabine National Wildlife Refuge, Louisiana. *Journal of Wildlife Management* 36:809-815.
- VON BERTALANFFY, L. 1960. Principles and theory of growth, p. 237-259. In W. W. Nowinski (ed.), *Fundamental Aspects of Normal and Malignant Growth*. Elsevier, Amsterdam, The Netherlands.
- WEBB, G. J. W., H. MESSEL, J. CRAWFORD, AND M. J. YERBURY. 1978. Growth rates of *Crocodylus porosus* (Reptilia: Crocodylia) from Arnhem Land, Northern Australia. *Australian Wildlife Research* 5:385-399.
- WEBB, G. J. W., R. BUCKWORTH, AND S. C. MANOLIS. 1983. *Crocodylus johnstoni* in the McKinley River Area, N.T. III. Growth, Movement and the Population Age Structure. *Australian Wildlife Research* 10:383-401.
- WILKINSON, P. M. 1983. Nesting ecology of the American alligator in coastal South Carolina: A study completion report. South Carolina Wildlife and Marine Resources Department, Charleston, South Carolina. 113 p.
- WOLFE, J. L., D. K. BRADSHAW, AND R. H. CHABRECK. 1987. Alligator feeding habits: New data and a review. *Northeast Gulf Science* 9:1-8.

Received for consideration, February 6, 1990

Accepted for publication, January 25, 1991